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STORM LOW IMPACT DEVELOPMENT (LID) - DESIGN CRITERIA

I. BIORETENTION (CELLS and RAIN GARDENS)

A. General Information

Bioretention Cells are considered "engineered rain gardens", and are for projects required to meet water quality and/or flow control standards. The generic term Rain Garden can be used to describe a small site, non-engineered BMP for flow control. Both are shallow landscaped depressions with a designed soil mix and plants that provide for storage, treatment, and infiltration of stormwater runoff. They can be design to receive runoff from any impervious surface area such as roof, driveway, parking area, road, or sidewalk. The soil in the depression is enhanced to promote infiltration and plant growth.

There are minimum design requirements for bioretention facilities, but the design can vary depending on the size, shape, location, and site conditions. For example, some facilities will have inflow piped in from a roof downspout, while others will receive runoff as sheet flow over a spillway from a parking lot. Since bioretention designs are not as standard as other stormwater facilities, the engineering details in this section are to be used as guidelines and may need additional site specific modifications.

B. Design Criteria

The Criteria below is primarily for Bioretention Cells (larger, engineered Rain Gardens). In addition to the design criteria below, see details L.01, L.02, L.03, and L.04. Small Site Residential Rain Gardens (see detail L.05) require less restrictive design criteria, depending on the size and site conditions.

1. Cell Design
   a. Cell shall be designed to drain in 24 hours. Water storage volume in cubic feet shall equal 0.25 times the square footage of the impervious surface area served, or sized using Western WA Hydrology Model (WWHM) or other approved continuous runoff model.
   b. If a single bioretention facility serves a drainage area exceeding 1 acre, a groundwater mounding analysis is required.
   c. Do not place geotextile fabric between the Bioretention Soil Mix (BSM) layer and the subgrade.
   d. Infiltration rate between 1 and 12 inches per hour.

2. Site and Setback Criteria
   a. Bioretention cells shall not be installed in sensitive area buffers or on slopes steeper than 20%. Cells proposed on slopes steeper than 15% or within 50' of a steep slope/landslide hazard area must be approved by a geotechnical engineer or engineering geologist.
   b. For sites with septic systems, bioretention cell must be located down-gradient of the primary and reserve drainfield areas, unless approved by engineer.
   c. Bioretention facilities must not create flooding or erosion problems on site or on adjacent properties.
   d. Minimum top width is 9' for bioretention cell in public right-of-way.

3. Plant Criteria
   a. See approved plant list in detail L.03.
   b. Consider visibility, site distance, and setbacks for safety with regard to plant species and location in bioretention cells in the public right-of-way.
   c. The BSM layer provides an excellent growth media, so plants will often attain or surpass maximum growth dimensions. Planting layouts should consider maximum dimensions for selected plants when assessing site distances and adjacent uses.
   d. For long, narrow cells in areas with high pedestrian traffic (like parking lots), consider incorporating narrow walkways across cells (with crushed rock or stone pavers) to keep pedestrians from walking on plants.

4. Under-drain Criteria
   a. Minimum pipe diameter is 4".
   b. Slotted subsurface drain PVC per ASTM D1785 SCH 40.
   c. Perforated PVC or flexible slotted HDPE pipe is not recommended.
   d. Slope at a minimum of 0.5% unless otherwise specified by an engineer.
   e. Wrapping the under-drain pipe with filter fabric is not recommended.
   f. Provide a clean out every 250-300 feet
   g. Under-drains should only be installed when a bioretention facility is:
      i. Located near sensitive infrastructure (e.g., unsealed basements) and potential for flooding is likely.
      ii. Used for filtering storm flows from gas stations or other pollutant hotspots (requires impermeable liner).
      iii. Areas with contaminated groundwater and soils.
      iv. In soils with infiltration rates below 1 inch per hour, or that are not adequate to meet maximum pool and system dewater rates.
      v. In an area that does not provide the minimum depth to a hydraulic restriction layer.

C. General Maintenance Requirements for Bioretention Cells and Rain Gardens
COK Maintenance Agreement is required for all bioretention cells and rain gardens. The maintenance agreement and standards are located in Policy D-7.

II. PERMEABLE PAVEMENT

A. General Information on Permeable Pavement
Permeable pavement is a structural groundcover that allows natural drainage and migration of water into the earth by permitting water to drain through it and infiltrate into the soil below. There are several different materials available, such as pervious concrete, porous asphalt, and permeable pavers. Permeable pavement systems require careful design, construction, and maintenance in order to provide good service life and proper drainage. Manufacturer's recommendations should be strictly followed for proprietary systems.

Permeable pavement can be applied to patios, driveways, sidewalks, parking areas, and roads that are privately owned and maintained. Permeable pavement for sidewalks is allowed in City of Kirkland road right-of-way if approved by the Public Works Director.

Permeable pavement should not be located over cisterns, utility vaults, underground parking, in high volume intersections, under solid waste dumpsters, or where there is a high risk of chemical spillage.

B. Pervious Concrete Design & Construction Guidelines

1. Limit the amount of construction equipment in areas set aside for pervious concrete to avoid over-compaction of the subgrade.
2. Ground water must be at least 3 feet below the aggregate base course layer.
3. Pervious concrete performs best when installed at slopes of 0-2% slope. For slopes between 2% and 10%, install impervious check dams in the base course. Location of check dams should follow topography and be shown on the plans. Do not place pervious concrete on slopes greater than 10%.
4. Immediately before placement of base aggregate and pervious concrete, remove any accumulation of fine material from erosion during construction with light equipment and scarify soils to a minimum depth of 6 inches.
5. Pervious concrete pavement shall be permeable enough to absorb water at a minimum rate of 100 inches per hour immediately after the pavement surface has been wetted continuously for at least 10 minutes. Compliance with this minimum rate shall be checked prior to construction approval of the pavement. Compliance may be checked using a simple bucket test in which 5 gallons of water are poured onto the pavement surface all at once from a 5 gallon bucket. If nothing but a scant amount of water puddles or runs off the surface, then the pavement is considered to meet the minimum rate of absorption. If this test is not conclusive, then a 6 inch ring sealed at the base of the pavement surface shall be used to measure the actual rate of absorption.
6. Pervious concrete should capture only direct rainfall; do not direct runoff from impervious surface onto the porous concrete (this increases clogging).
7. If existing soils have low permeability and an infiltration rate of 0.5" per hour or less, provide an under-drain to an approved outlet structure.
8. Protect pervious concrete from fines and other sediment during construction by covering with visqueen or similar impervious material.
9. Do not apply paint or other sealant to pervious concrete.
10. Do not include a choker course or geotextile fabric with pervious concrete.
11. Joint pervious concrete like traditional impervious concrete.
12. For larger areas, like streets or parking lots, install a ribbon strip of impervious (like traditional concrete) around the area of pervious pavement.
13. For areas that transition from pervious concrete to traditional impervious asphalt or concrete, install a concrete divider or extend the pervious reservoir base course under the impervious surface to account for settling.
14. Include an emergency overflow in the design in case pavement becomes clogged.
15. Consider using traditional concrete for parking lot entrance and areas of heavy traffic load, and pervious concrete for areas with less vehicular use.

C. Porous Asphalt Design Guidelines

1. Limit the amount of construction equipment in areas set aside for porous concrete to avoid over-compaction of the subgrade.
2. Ground water must be at least 3 feet below the aggregate base course layer.
3. Porous asphalt performs best when installed at slopes of 0-2% slope. For slopes between 2% and 5%, install impervious check dams in the base course. Location of check dams should follow topography and be shown on the plans. Do not place porous asphalt on slopes greater than 5%.
4. Immediately before placement of base aggregate and porous asphalt, remove any accumulation of fine material from erosion during construction activities with light equipment and scarify soils to a minimum depth of 6 inches.

5. Porous asphalt shall be installed over a choker course, a base course, and non-woven filter fabric placed over the subgrade.
6. Porous asphalt pavement shall be permeable enough to absorb water at a minimum rate of 100 inches per hour immediately after the pavement surface has been wetted continuously for at least 10 minutes. Compliance with this minimum rate shall be checked prior to construction approval of the pavement. Compliance may be checked using a simple bucket test in which 5 gallons of water are poured onto the pavement surface all at once from a 5 gallon bucket. If nothing but a scant amount of water puddles or runs off the surface, then the pavement is considered to meet the minimum rate of absorption. If this test is not conclusive, then a 6 inch ring sealed at the base of the pavement surface shall be used to measure the actual rate of absorption.
7. Porous asphalt should capture only direct rainfall; do not direct runoff from impervious surface onto the porous concrete (this increases clogging).
8. If existing soils have low permeability and an infiltration rate of 0.5" per hour or less, provide an under-drain to an approved outlet structure.
9. Protect porous asphalt from fines and other sediment during construction by covering with visqueen or similar impervious material.
10. Do not apply paint or other sealant to porous asphalt.
11. For larger areas, like streets or parking lots, install a ribbon strip of impervious (like traditional concrete) around the area of porous asphalt.
12. For areas that transition from porous asphalt to traditional impervious asphalt or concrete, install a concrete divider or extend the pervious reservoir base course under the impervious surface to account for settling.
13. Include an emergency overflow in the design in case pavement becomes clogged.
14. Consider using traditional asphalt for parking lot entrance and areas of heavy traffic load, and porous asphalt for areas with less vehicular use.

D. Permeable Paver Design Guidelines
1. Follow design and installation recommendations from the product manufacturer.
2. Limit the amount of construction equipment in areas set aside for porous concrete to avoid over-compaction of the subgrade.
3. Ground water must be at least 3 feet below the aggregate base course layer.
4. Do not place permeable pavers on slopes greater than 12%. Install impervious check dams in base course as directed by manufacturer. Location of check dams should follow topography and be shown on the plans.
5. Base course is a minimum of 6 inches of clean, angular drain rock, with less than 2% fines (material passing the #200 sieve) and 5% passing the #8 sieve.
6. Immediately before placement of base aggregate and permeable pavers, remove any accumulation of fine material from erosion during construction activities with light equipment and scarify soils to a minimum depth of 6 inches.
7. Permeable pavement shall be permeable enough to absorb water at a minimum rate of 100 inches per hour immediately after the pavement surface has been wetted continuously for at least 10 minutes. Compliance with this minimum rate shall be checked prior to construction approval of the pavement. Compliance may be checked using a simple bucket test in which 5 gallons of water are poured onto the pavement surface all at once from a 5 gallon bucket. If nothing but a scant amount of water puddles or runs off the surface, then the pavement is considered to meet the minimum rate of absorption. If this test is not conclusive, then a 6 inch ring sealed at the base of the pavement surface shall be used to measure the actual rate of absorption.
8. Permeable pavement should capture only direct rainfall; do not direct runoff from impervious surface onto the porous concrete (this increases clogging).

9. If existing soils have low permeability and an infiltration rate of 0.5" per hour or less, provide an under-drain to an approved outlet structure.
10. Protect permeable pavement from fines and other sediment during construction by covering with visqueen or similar impervious material.
11. Do not apply paint or other sealant to permeable pavement.
12. For driveways, streets, and parking lots install a ribbon strip of impervious (like traditional concrete) around the area of permeable pavement.
13. Include an emergency overflow in the design in case pavement becomes clogged.

E. General Maintenance Requirements for Permeable Pavement

Maintenance standards for permeable pavement are located with Policy D-7.